Chapter

Modeling Data in the Organization

System Modeling

- **Process Modeling**
- **Data Modeling**
- **Object Modeling**

Process-Oriented Approach

Data-Oriented Approach

Object-Oriented Approach

Entity Relationship (E-R) Model

- A detailed, logical representation of the data for an organization or business area

- Expressed in terms of Entities, Relationships and Attributes

- E-R Diagram: A Graphical Representation of an E-R Model

Entity

- An object or concept that is important to the business and the organization chooses to record data
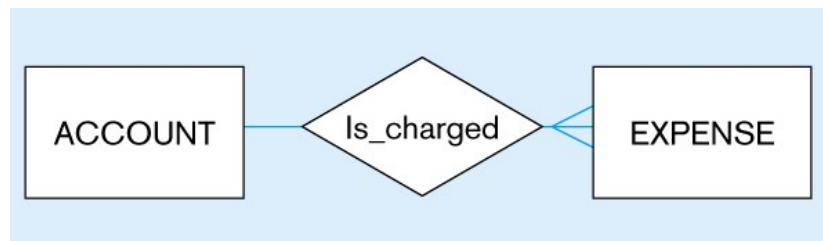
Entity Symbol

What Should an Entity Be?

- SHOULD BE:
  - An object that will have many instances in the database
  - An object that will be composed of multiple attributes
  - An object that we are trying to model

- SHOULD NOT BE:
  - A user of the database system
  - An output of the database system (e.g. a report)

Inappropriate entities

System user

System output
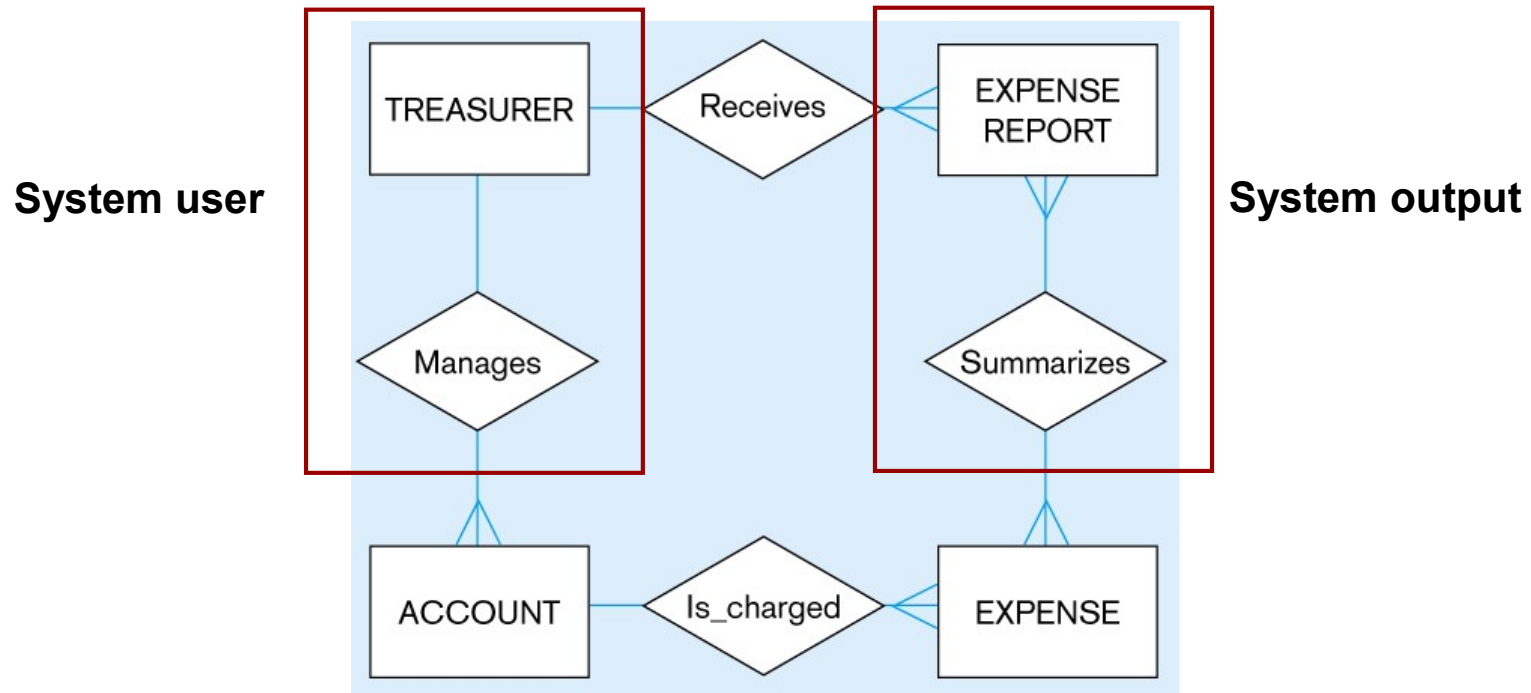
Appropriate entities

Terms

Entity Instance: Single occurrence of an entity type.

Attribute: Property or characteristic of an entity that is of interest to the organization.

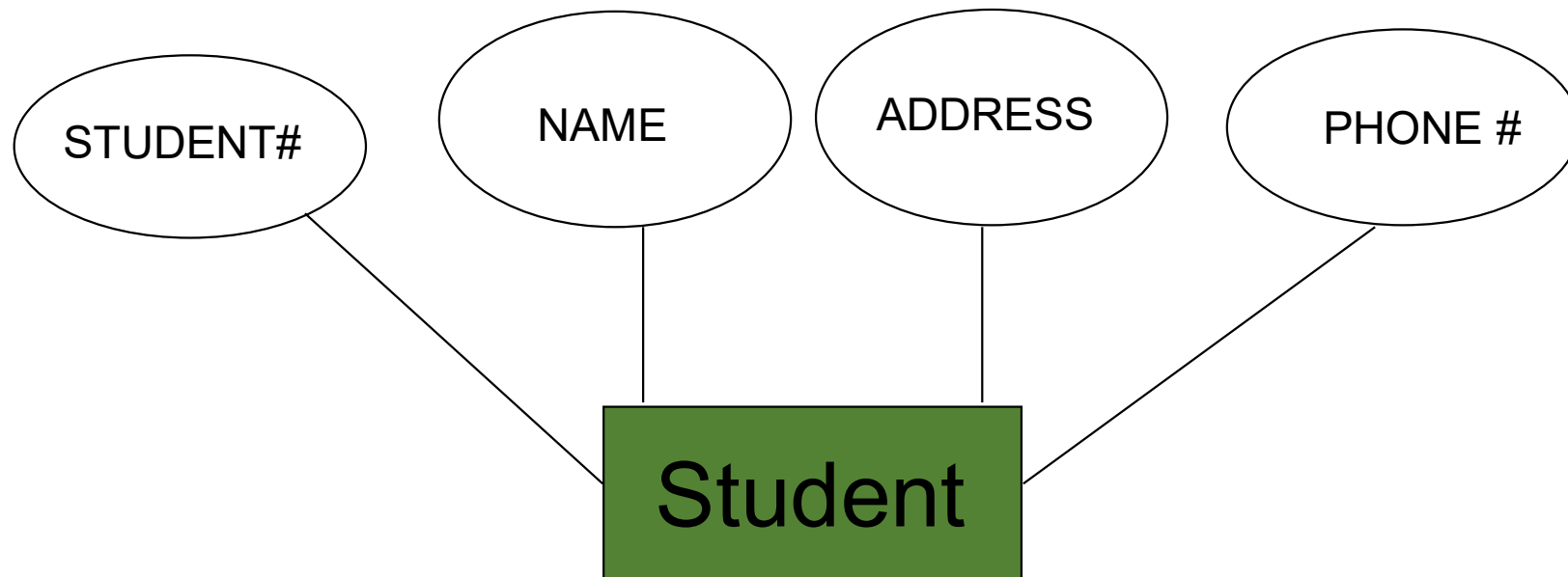**Composite Attribute:** An attribute that can be broken down into its component parts

More Terms

Single Attribute: Cannot be broken down into smaller components

Multivalued Attribute: May take on more than one value for a given entity instance

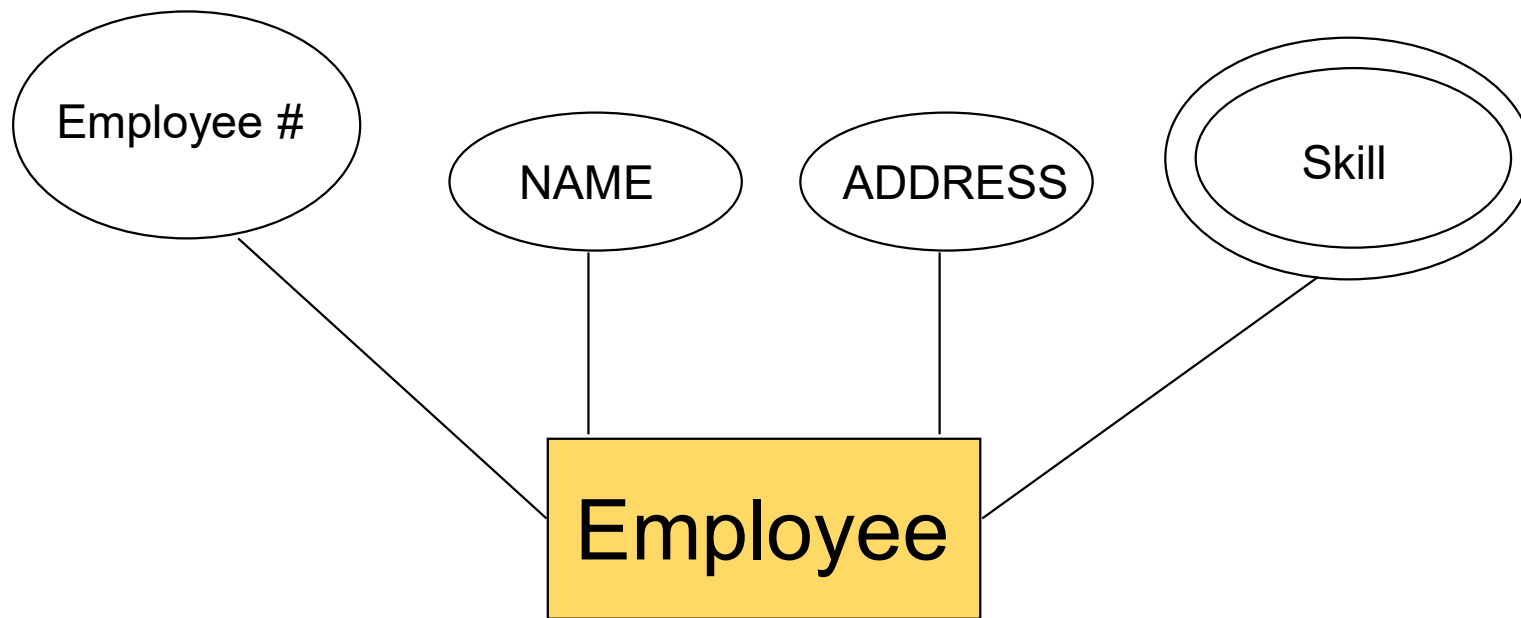Derived Attribute: Values can be calculated form related attribute values
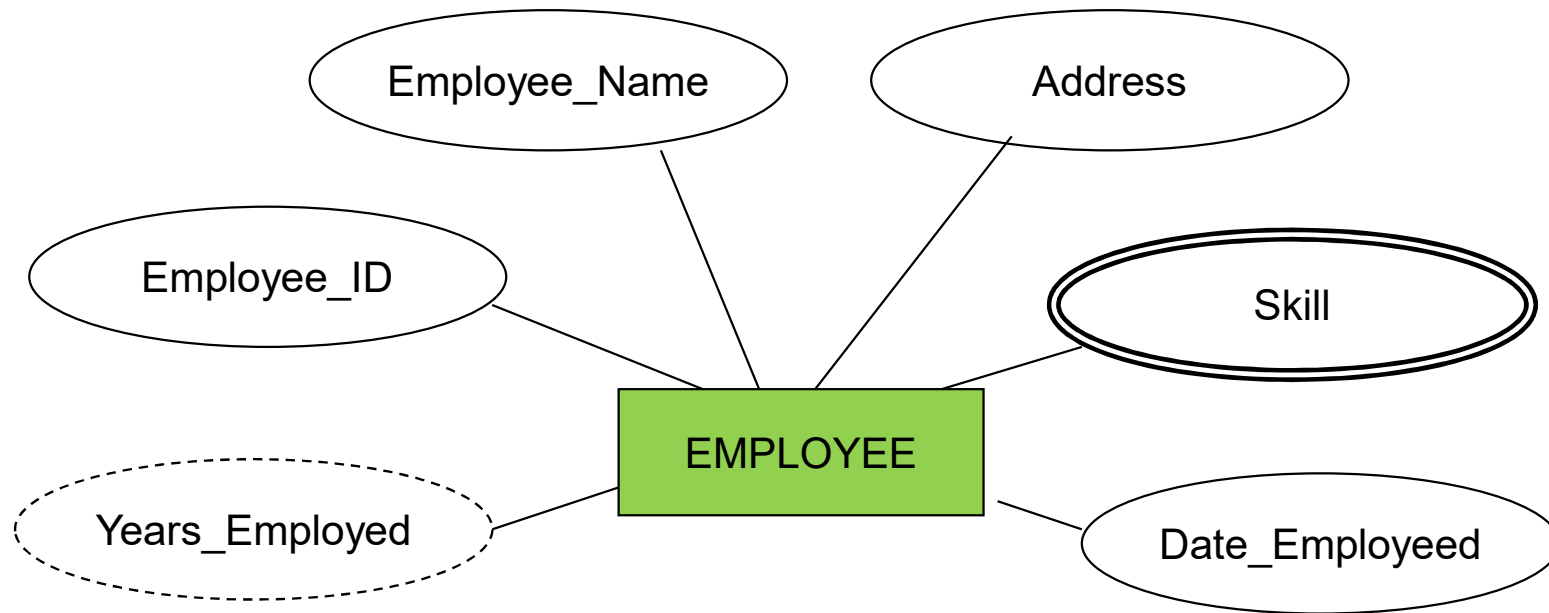
Simple Example of Entity

Multivalued Attributes

An attribute that can have more than one value for each entity instance

Example (Multi/Derived)

Example (Entity Type)

Entity Type: **Employee**

Attributes: Employee #
                    Name
                    Address
                    City
                    State
                    Zip
                    Year Hired
                    Birthdate

Instance of Employee

Employee #   642-17-8360

Name   Michelle Brady

Address   100 Pacific Ave

City   San Francisco

State   CA

Zip   98317

Year Hired   1989

Birthdate   6-19-64

More Terms

Identifier: an attribute (or combination of attributes) that uniquely identifies each instance of an entity type.

Composite Identifier: An identifier that consists of a composite attribute

Simple and Composite Identifier
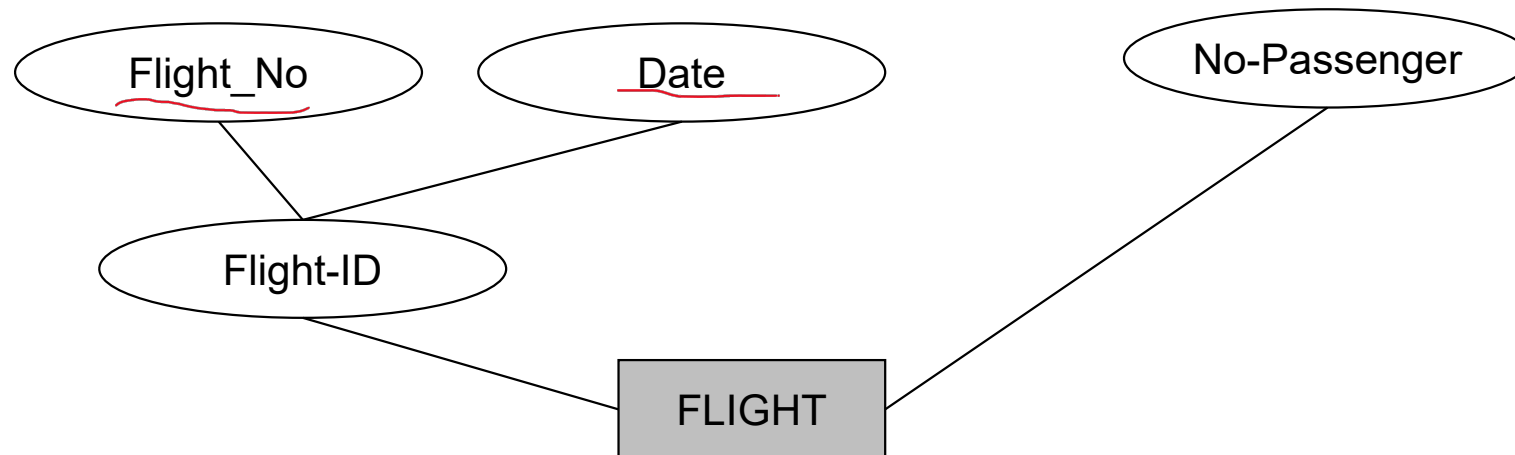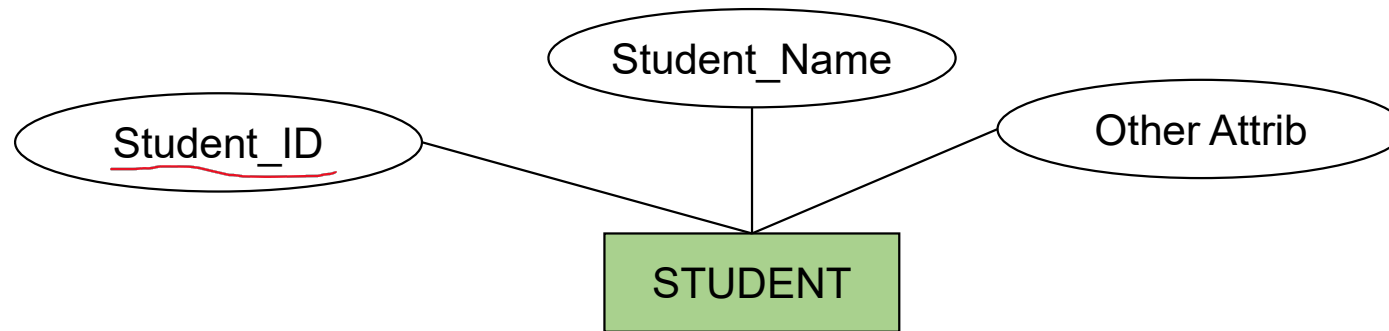
Definitions

- Primary Key - a data item that is unique to each record
- Compound Key - primary key consisting of multiple fields
- Keys are used to relate several tables together.
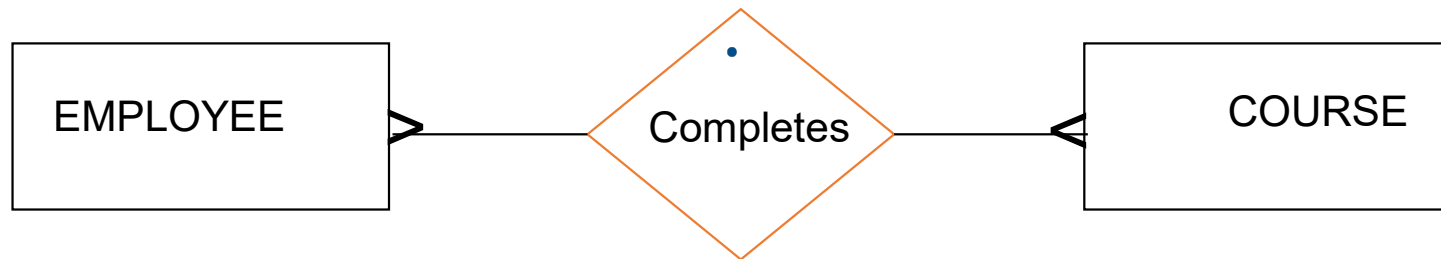- Foreign Key - a field in one table that is a primary key to another table.

Characteristics of Identifiers

- Use attribute(s) that will not change over time

- Must never be empty "null"

- Avoid intelligent keys: e.g. containing locations or people that might change.

- Substitute new, simple keys for long, composite keys

Relationships

An association between instances of one or more entity types that is of interest to the organization (VERB)

```
┌─────────────┐        ◇              ┌─────────────┐
│  EMPLOYEE   │─────Completes─────────│   COURSE    │
└─────────────┘                       └─────────────┘
```

Relationship

- Associations between entities captured by business rules
    - each customer places any number of customer orders
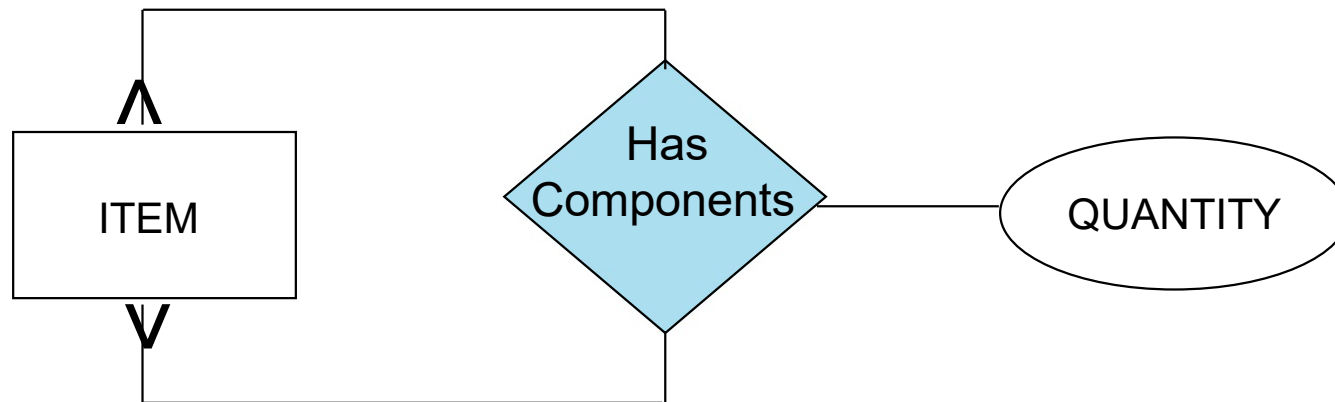   - each customer order is placed by exactly one customer

- End of oct 21

Degree of a Relationship

- The number of entity types that participates in a relationship
    - Unary: (degree 1) also called "Bill of Materials" or "Recursive"
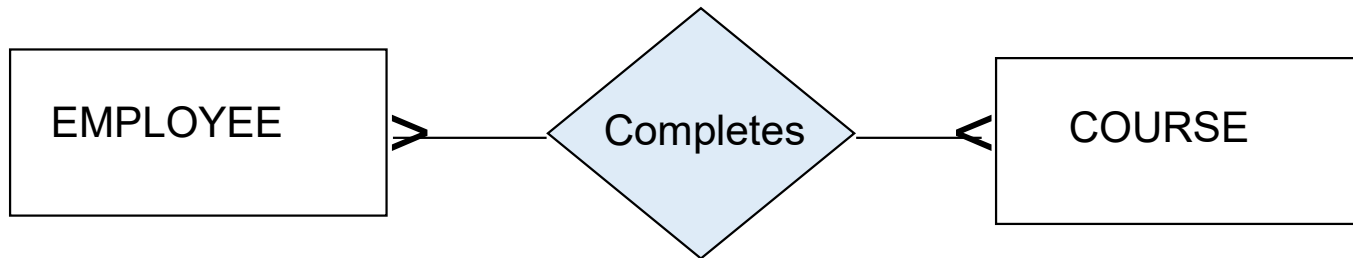   - Binary: (degree 2) Most common
    - Ternary: (degree 3)

Bill-of-Materials (Unary)

One entity related to another of the same entity type

Idea that entities can be components of other items as well as themselves
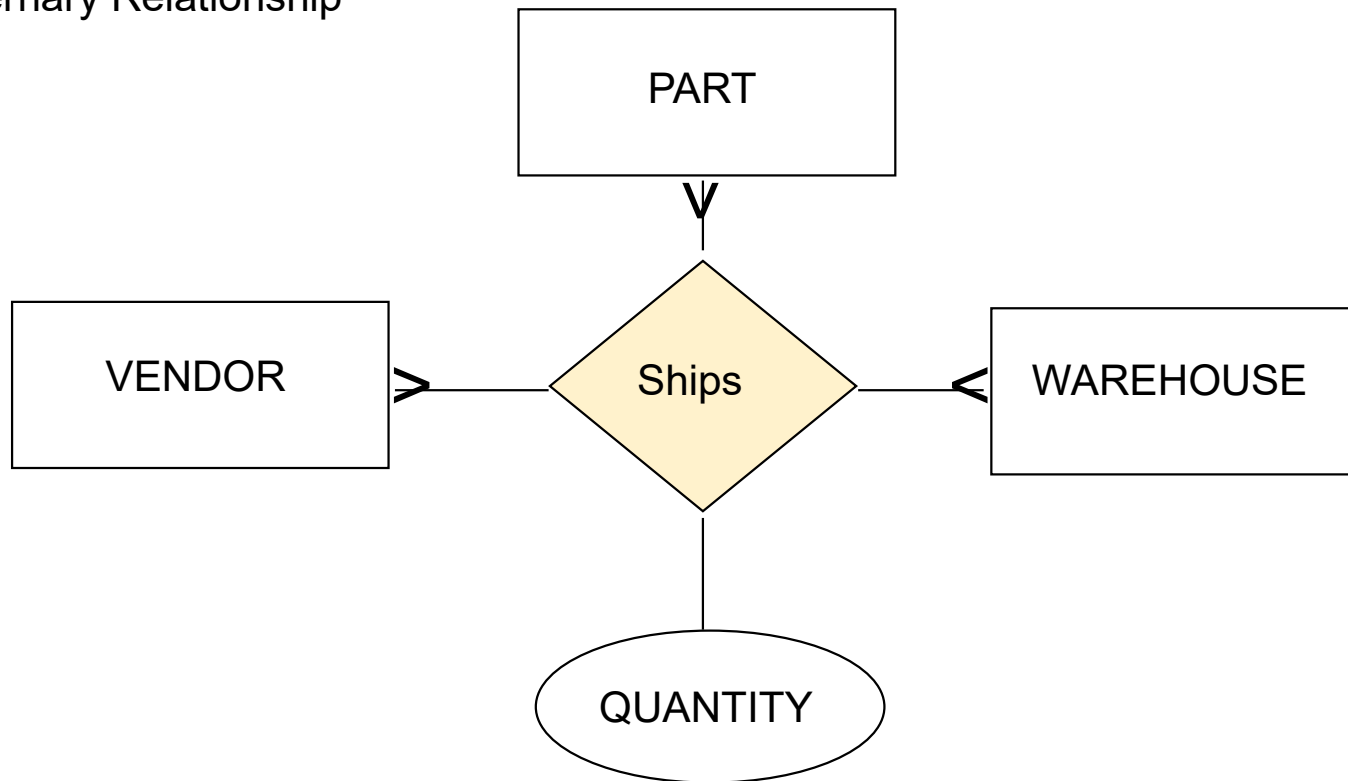
Examples of Relationship Degrees

Binary Relationship

Entities of two different types related to each other

Examples of Relationship Degrees
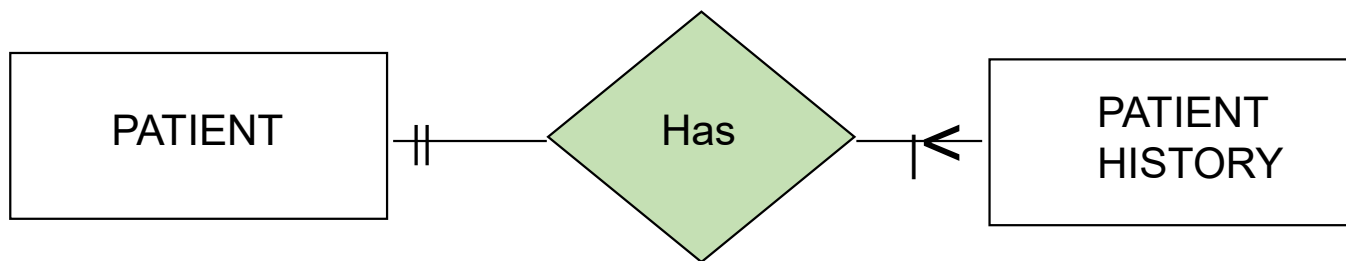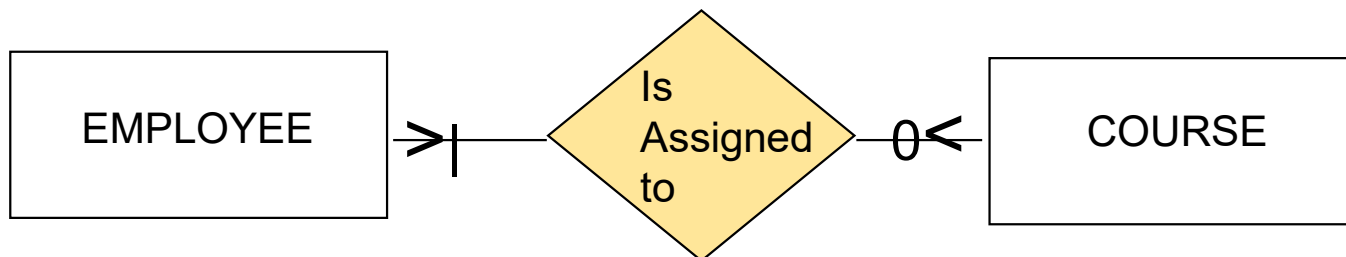
Ternary Relationship

Cardinality

The number of instances of an entity with another entity

PATIENT — Has — PATIENT HISTORY

Mandatory cardinalities

EMPLOYEE — Is Assigned to — COURSE

One optional, One mandatory cardinality

Cardinality of Relationships

- One-to-One
  - Each entity in the relationship will have exactly one related entity
- One-to-Many
  - An entity on one side of the relationship can have many related entities, but an entity on the other side will have a maximum of one related entity
- Many-to-Many
  - Entities on both sides of the relationship can have many related entities on the other side

Cardinality

- Two symbols on each end of the relationship line
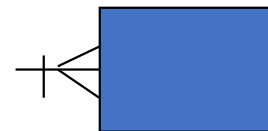
<u>Outside</u>   <u>Inside</u>

Maximum   Minimum

Mandatory   Many

Min 1 Max 1

Optional

Strong vs. Weak Entity

- Strong Entity Type: an entity that exists independent of other entity types
    - has its own unique identifier
    - represented with single-line rectangle

- Weak Entity Type: An entity whose existence depends on a strong entity type. It cannot exist on its own
    - does not have a unique identifier
    - represented with double-line rectangle

Weak Entity Terms

- Identifying Owner: The entity type on which the weak entity type depends

- Identifying Relationships: The relationship between a weak entity and its owner
 - represented with double line diamond

Example of Weak Entity Type
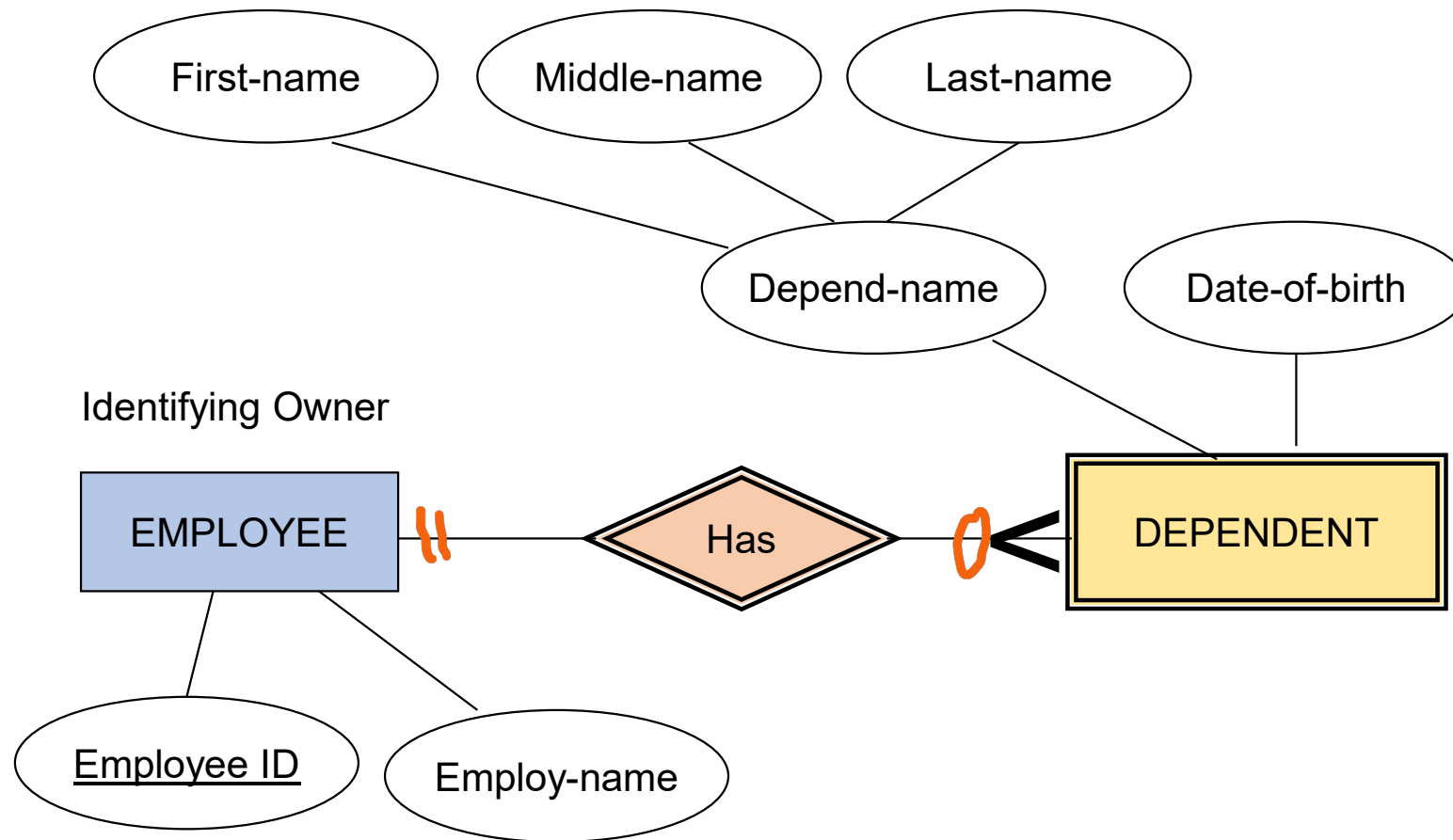
Associative Entities

- It's an entity – it has attributes

- AND it's a relationship – it links entities together

- When should a *relationship with attributes* instead be an *associative entity*?
  - All relationships for the associative entity should be many
  - The associative entity could have meaning independent of the other entities
  - The associative entity preferably has a unique identifier, and should also have other attributes
  - The associative may be participating in other relationships other than the entities of the associated relationship
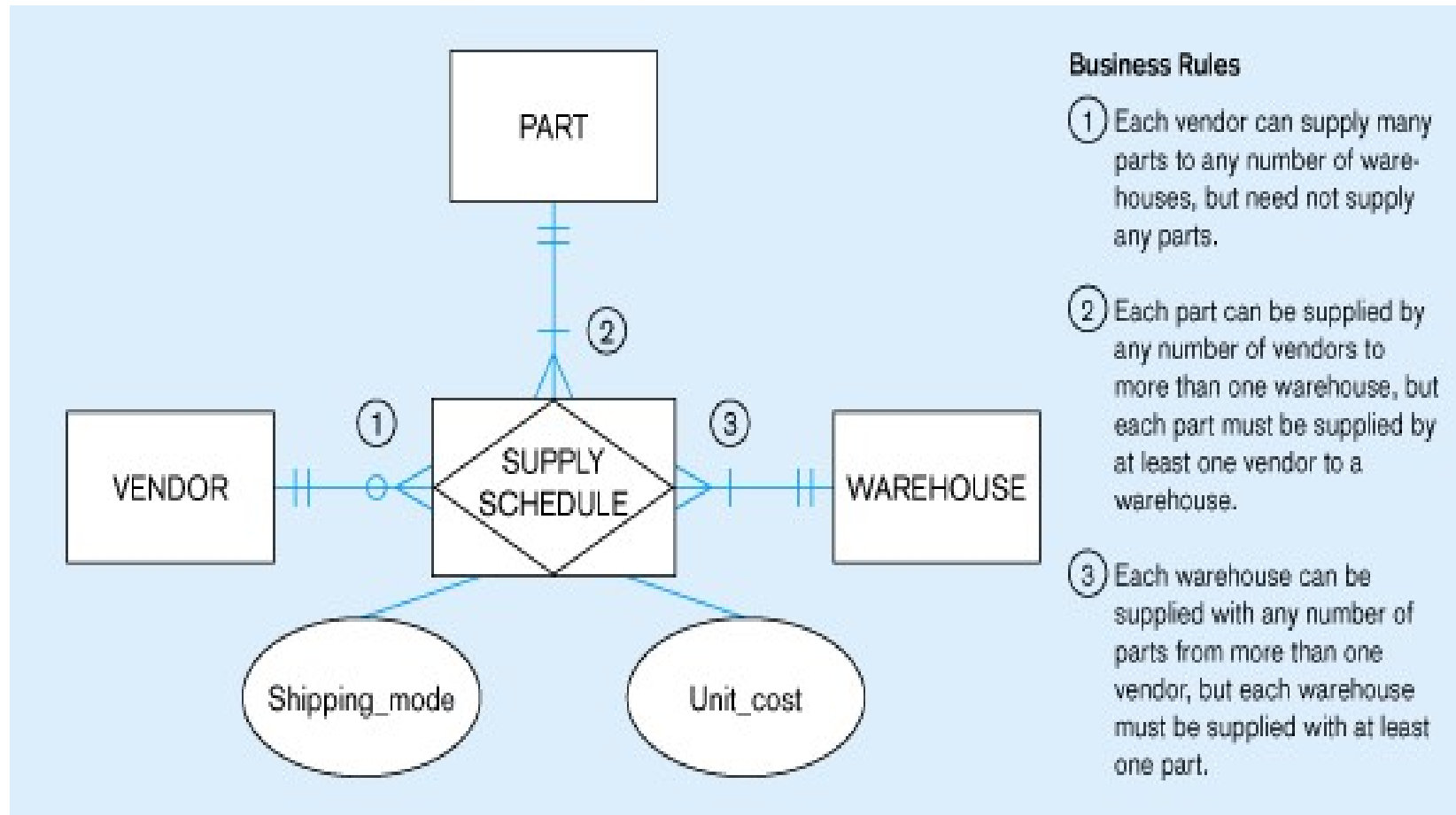 - Ternary relationships should be converted to associative entities

An associative entity (CERTIFICATE)
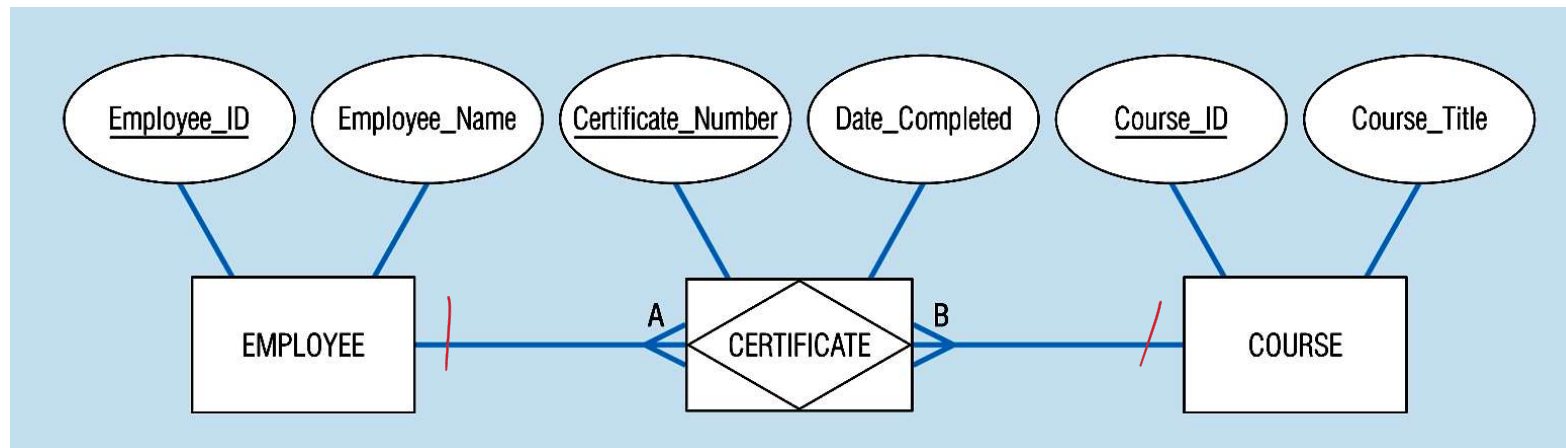
- An entity that associates the instances of one or more entity types and contains attributes that are peculiar to the relationship between those entity instances.

- Associative entity involves a rectangle with a diamond inside.
Note that the many-to-many cardinality symbols face toward the associative entity and not toward the other entities

Ternary relationship as an associative entity

Business Rules

1. Each vendor can supply many parts to any number of warehouses, but need not supply any parts.

2. Each part can be supplied by any number of vendors to more than one warehouse, but each part must be supplied by at least one vendor to a warehouse.

3. Each warehouse can be supplied with any number of parts from more than one vendor, but each warehouse must be supplied with at least one part.
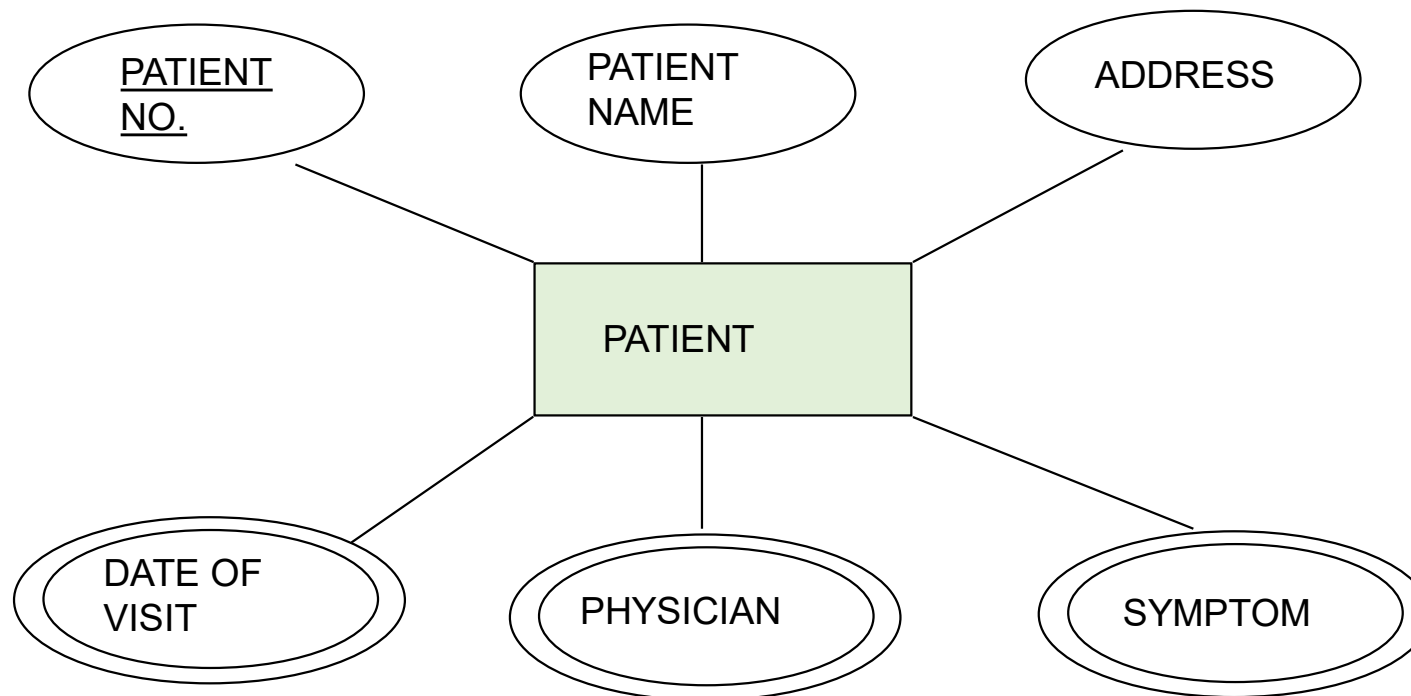
Benefits of Identifying Relationship

- Data Integrity
  - Existing dependencies are enforced since the primary key is shared therefore the weak entity cannot exist unless the parent exists

- Ease of Access to Dependent Entity
  - We can locate a movie copy if we know the movie # and copy #

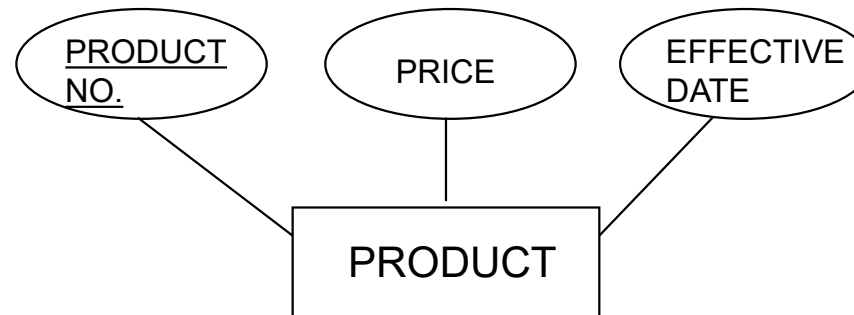# Some Modeling Challenges

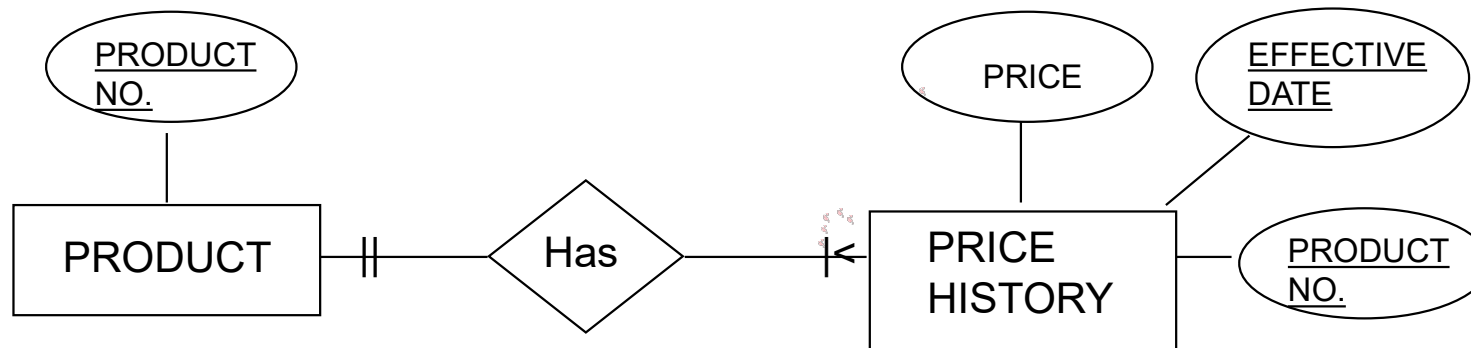- Multivalued Attributes (repeating groups)

Repeating Group Removed
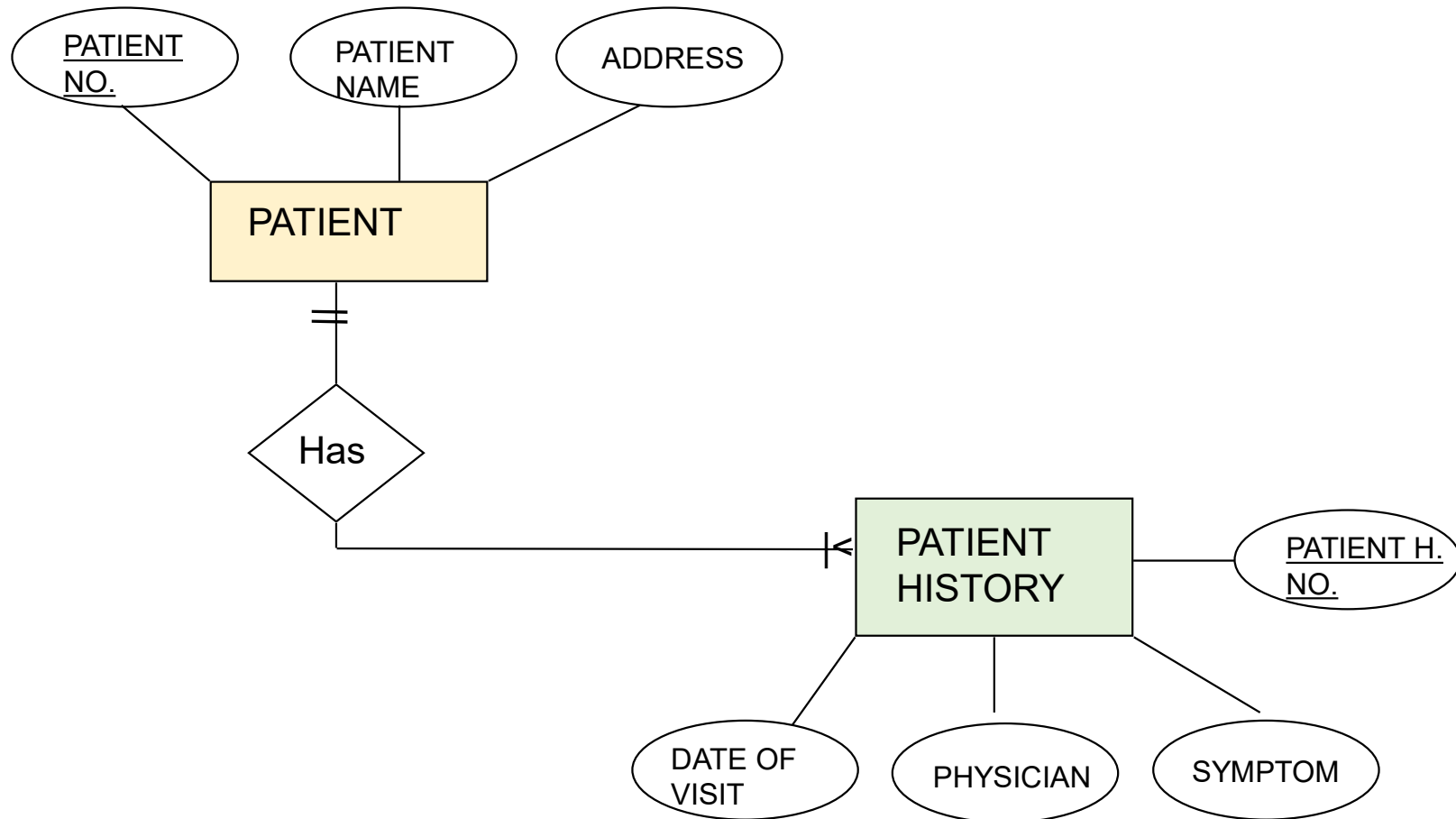
Modeling Time Dependent Data

- Time Stamp: a time value is associated with any data value

Relational Databases

- Views all data in the form of tables
    - Tables = entities
    - Columns = attributes (characteristics of an entity
    - Row = instance (occurrence) of an entity
    - Relationships between entities represented by values stored in columns,correspond to primary key-foreign key equivalencies in related tables

In Class Exercise 4

- Draw an ER diagram for the Vehicle Rental System considering only Customer, Vehicle, Reservation and Rental History entities with a reasonable amount of attributes. Show all necessary relationships with cardinatilies. Show also identifiers.

1. List 4 possible Entities (excluding Employee entity) for the Vehicle Rental System considering all activities that can be organized by the system.

2. List 5 possible attributes (including one multivalued and one derived attributes, if possible) for each entity listed.

3. List 3 possible relationships and their cardinalities between these listed Entities.

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